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(54) Title: FRONT LOAD PRESSURE JACKET SYSTEM WITH SYRINGE HOLDER			
(57) Abstract			
A pressure jacket system of the invention is used to permit the front loading and removal of a syringe (214) from an injector (20), and includes a jacket cylinder (216) having an open front end (218) for receiving a syringe (214) and a rear end coupled to the injector front face (23), first and second tie rods (238, 240) having rear ends pivotally attached to the injector front face (23) by pivots and bushings (230, 234, 232, 236), and a front retaining plate (222) attached to the front ends of the first and second tie rods (238, 240), such that the retaining plate (222) and tie rods (238, 240) are pivotable between a closed position for holding the syringe (214) within the jacket cylinder (216) and an open position to allow the insertion and removal of the syringe (214) from the jacket cylinder (216).			

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### Description

## FRONT LOAD PRESSURE JACKET SYSTEM WITH SYRINGE HOLDER

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## TECHNICAL FIELD OF THE INVENTION

This invention relates to pressure jacket systems for securing a syringe in an injector head. More specifically, the invention relates to pressure jacket systems which allow front loading and removal of a syringe, and which hold the syringe securely to an injector head during injection procedures.

## BACKGROUND OF INVENTION

In the medical field, patients often are injected with fluids in procedures such as angiography. In such procedures, which require controlled injection of a large volume of fluid into a patient, a needle is used as a conduit for the fluid which is connected to the syringe by a connector tube. The syringe is mounted on a motorized injector having an injector head.

For long term compatibility with injectable fluids, syringes may be made of polypropylene with a certain minimum wall thickness. The thickness is critical as typical pressures of up to 1200 p.s.i. are used to inject the fluids into a patient. For safety and sanitary reasons, different disposable syringes are used for different fluids and different patients.

Pressure jackets are known in the art for enclosing and retaining syringes while in use. A pressure jacket serves to limit radial expansion of a syringe which may lead to bursting or to leaks of the pressurized fluid around the seals of the syringe plunger. Another function of a pressure jacket is to prevent forward motion of the syringe. For example, typically a force of 2000 pounds is required to restrain the forward motion of a 200 ml syringe with a cross-section of  $1.7 \text{ in}^2$  at 1200 p.s.i.

Certain present pressure jackets are one piece designs, where the syringe is inserted into the jacket from the rear end of the jacket. An example of such a pressure jacket is found in U.S. Patent No. 4,677,980, assigned to the common assignee of this application. The neck of the syringe protrudes from the front end of the pressure jacket for connection of fluid lines which lead to the patient. Because the diameter of the syringe neck is much smaller than that of the syringe barrel, it can withstand both radial and forward force.

However such an arrangement causes a problem when the syringe is removed from the pressure jacket. The neck of the syringe must pass through the present pressure jacket configurations. This requires the patient fluid path to be disconnected which presents a potential

biohazard and may result in spilling fluids onto the pressure jacket. Additionally, fluid spilled during loading and purging air from the syringe may get inside the pressure jacket and require cleaning.

Thus, a pressure jacket system is needed which permits a syringe to be front loaded onto 5 an injector head and removed from the injector head without disconnecting the patient fluid path. Further, a pressure jacket system is needed which reduces the materials required for the manufacture of the syringe.

#### SUMMARY OF INVENTION

10 The present invention relates to front loadable pressure jacket systems for use with injectors having an injector head with a housing and a front opening. A syringe is connected to the injector front opening to allow the flow of fluids through the syringe. A pressure jacket holds the syringe to the injector head. A piston extendible through the injector front opening imparts motive force to a plunger in the syringe to cause fluid flow.

15 One embodiment of the present invention is a pressure jacket having first and second jacket halves each having interior surfaces conformable to the exterior surface of the syringe. A hinge pin extends from the front face of the injector head. The first and second jacket halves are rotatably mounted on the hinge pin. The halves may be placed in an open position allowing insertion and removal of the syringe or a closed position so that the jacket surrounds the syringe.

20 A second embodiment of the present invention includes a pressure jacket with first and second jacket halves, where each jacket half has a front or distal end and a rear or proximal end. A hinge for rotational connection to the injector's front face allows the first and second jacket halves to be placed in an open position, allowing insertion and removal of the syringe, and a closed position such that the jacket substantially surrounds the syringe. A locking ring is 25 disposed around the first and second jacket halves. The locking ring is placed in a position over the front ends of the first and second jacket halves when in the closed position and the ring is placed in a position near the proximal ends of the jacket halves when in the open position.

30 A third embodiment of the present invention includes a pressure jacket which has a hollow cylinder portion with an open distal end and a rear end coupled to the injector head. The cylinder has at least one locking finger having front and rear ends, and a pivot axis disposed near the rear end. The pivot axis is connected to the open distal end of the cylinder. The locking finger is pivotable to a closed position such that the front end of the finger acts to hold the syringe within the cylinder. The finger is pivotable to an open position to allow the insertion or removal of the syringe.

A fourth embodiment of the present invention includes a pressure jacket having a jacket cylinder with an open front end and a rear end coupled to the injector head. A first tie rod has a rear end attached to the injector head and a front end which is attached to a first front plate. The first front plate is pivotable between a closed position for holding the syringe within the jacket cylinder and an open position for allowing the insertion or removal of the syringe. A second tie rod likewise has a rear end attached to the injector head and a front end attached to a second front plate. The second front plate is pivotable between a closed position for holding the syringe within the jacket cylinder, and an open position for allowing the insertion or removal of the syringe.

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10 A fifth embodiment of the present invention includes a pressure jacket with a jacket cylinder having an open front end and a rear end coupled to the injector head. A first pivot is coupled to the injector head and a first tie rod is attached to the first pivot. A second pivot is coupled to the injector head and a second tie rod is attached to the second pivot. A front retaining plate joining the front ends of the tie rods allows the retaining plate to be pivotable between a closed position for holding the syringe within the jacket cylinder and an open position to allow the insertion or removal of the syringe from the jacket cylinder.

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20 A sixth embodiment of the present invention includes a pressure jacket which has a jacket cylinder formed around a longitudinal axis and having an open front end and a rear end. The jacket cylinder is transversely pivoted to the front face of the housing to allow the cylinder jacket to be pivoted between a closed position and an open position. An arm having a rear end affixed to the injector head is attached to a retaining member. The retaining member retains the syringe in the jacket cylinder when the jacket cylinder is in a closed position. The jacket permits the loading or removal of the syringe when the jacket cylinder is in an open position.

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30 A seventh embodiment of the present invention includes a pressure jacket which has a slideable canopy retractable within the injector head. An arm having a rear end is coupled to the injector head. The front end of the arm is coupled to a retaining member and retains the syringe. The canopy slides to a closed position to retain the syringe and slides to an open position to allow the insertion or removal of the syringe.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is a schematic view of an injector head and front loading syringe that may be used with the embodiments of the present invention;

Fig. 2 is a perspective view of a first embodiment of the invention in an open position;

Fig. 3 is a front elevational view of the first embodiment of the invention in an open position;

Fig. 4 is a perspective view of the first embodiment of the present invention in a closed position;

5 Fig. 5 is a front elevational view of the first embodiment of the present invention in a closed position;

Fig. 6 is a perspective view of a second embodiment of the present invention in an open position;

10 Fig. 7 is a perspective view of the second embodiment of the present invention in a closed position;

Fig. 8 is an exploded view of a third embodiment of the present invention;

Fig. 9A is an alternate configuration of the locking fingers of the third embodiment of the present invention in an open position;

Fig. 9B is an alternate configuration of the locking fingers of Fig. 9A in a closed position;

15 Fig. 10 is a front elevational view of a third embodiment of the present invention in an open position;

Fig. 11 is a front elevational view of the third embodiment of the present invention in a closed position;

20 Fig. 12 is a perspective view of a fourth embodiment of the present invention in an open position;

Fig. 13 is a perspective view of the fourth embodiment of the present invention in a closed position;

Fig. 14 is a perspective view of a fifth embodiment of the present invention in an open position;

25 Fig. 15 is a perspective view of the fifth embodiment of the present invention in a closed position;

Fig. 16 is a perspective view of a sixth embodiment of the present invention in an open position;

30 Fig. 17A is a perspective view of the sixth embodiment of the present invention in a closed position;

Fig. 17B is an isolated view of an alternative to the sixth embodiment of the present invention;

Fig. 18 is a perspective view of a seventh embodiment of the present invention in a partially open position; and

Fig. 19 is a front elevational view of the seventh embodiment of the present invention in a closed position.

#### DETAILED DESCRIPTION OF THE INVENTION

5 Fig. 1 shows an injector head indicated generally at 20 and a syringe 22 which may be used in connection with various embodiments of the present invention. The injector head 20 includes a housing 21 and a front face 23. The injector head 20 is used to actuate syringe 22 which is mounted on the injector head 20. The syringe 22 includes a tubular body 24 and a plunger 26 slidably positioned therein. In operation, the rear of the syringe 22 is fixed in or  
10 against an opening 30 on the injector front face 23. Syringe 22 may be affixed to opening 30 by any suitable means, such as mounting flanges (not shown), as described in U.S. Patent No. 5,383,858, assigned to the common assignee of this application and which is fully incorporated herein by reference. Any of the pressure jacket systems which are described below may be used to retain syringe 22 when syringe 22 is affixed to the injector front face 23. The fluid within  
15 syringe 22 is pushed forward by a drive means, such as motorized piston 32, extendable and retractable through opening 30, which engages the rear surface 29 of plunger 26 to push plunger 26 forward in the syringe.

20 Figs. 2-3 show views of a first embodiment of the present invention in an open position and Figs. 4-5 show views of the first embodiment in a closed position. Specifically, as shown in detail in Fig. 2, a fluid injector 40 includes a pressure jacket 42 which is of an axially split or "clam shell" type. The pressure jacket 42 is mounted to the front face 23 of the injector head 20. When syringe 46 is installed into pressure jacket 42, as more fully described below, motorized piston 32 when driven forward, engages a syringe plunger (not shown) and pushes the plunger forward in the body of a syringe 46 to force fluid out of the syringe tip 48. Syringe 46, 25 preferably manufactured of a clear plastic, includes a body 50, a neck 52 connected to the body 50 and a luer connector 54 connected to the neck 52. A connector tube (not shown) may be connected to luer connector 54 which delivers fluid to the patient.

30 As shown in Figs. 2-3, pressure jacket 42 which includes a first jacket half 56 and a second jacket half 58, is preferably manufactured from a clear plastic so that the position of the plunger within installed syringe 46 may be observed. The first jacket half 56 and the second jacket half 58 have interior surfaces, 64 and 66, respectively, which conform to the exterior surface of the body 50 of the syringe 46. The first and second jacket halves 56 and 58 are joined by a pivot hinge 60 which allows the first jacket half 56 and the second jacket half 58 to be swung to an open position, as shown in Figs. 2 and 3. Pivot hinge 60 has one end thereof affixed

to the forward wall of injector head 20 at a point below injector head opening 30, although in other embodiments the pivot hinge 60 may otherwise be radially displaced from opening 30. For example, if it is desired that jacket halves 56 and 58 open to the side instead of from the top, the pivot hinge 60 would be positioned to one side of opening 30. As shown in Fig. 2, the pivot hinge 60 is preferably parallel to axis A of the injector piston movement. With the pressure jacket 42 in the open position, syringe 46 may be inserted between the first jacket half 56 and the second jacket half 58. The two jacket halves 56 and 58 are then closed and locked by means of a latch 62, as shown in Figs. 4 and 5, which in the illustrated embodiment is attached to first jacket half 56. Alternatively, one of the first or second jacket halves 56 or 58 may be fixed to the forward wall 23 of injector head 20 and the other jacket half may be pivotally mounted to the forward wall 23 of injector head 20.

As shown in Figs. 2-5, the first embodiment of the present invention allows front loading and removal of syringe 46 and any tubes attached thereto while minimizing fluid spills. Further, as syringe 46 is retained within pressure jacket 42, the amount of material required to manufacture syringe 42 is reduced because the pressure jacket 42, instead of the syringe walls, bears the majority of the pressure force exerted during a fluid injection procedure.

A second embodiment of the present invention is shown in Figs. 6 and 7. Fig. 6 shows a fluid injector 70 having a pressure jacket system 72 in an open position which permits the loading and removal of a syringe 76. Pressure jacket 72, a generally "alligator jaw" type, is hingedly affixed to an injector head 20 to which syringe 76 may be releasably installed. Specifically, as shown in Fig. 7, syringe 76 is held by a combination of a first or top jacket half 78 and a second or bottom jacket half 80, together forming pressure jacket 72, and a locking ring 82. Both top jacket half 78 and bottom jacket half 80 are preferably made of clear plastic and have a semi-cylindrical shape. Interior semi-cylindrical surfaces 84 and 86 of top and bottom jacket halves 78 and 80, respectively, conform to the exterior surface of the body of the syringe 76. Jacket halves 78 and 80 have respective rear ends 88 and 90 located near the injector front face 23 and front ends 92 and 94 which coact to form an opening for the syringe neck 97. The front ends 92 and 94 have interior surfaces which mate with the exterior conical transition region 96 of syringe 76.

When the top jacket half 78 and bottom jacket half 80 are in the closed position, as shown in Fig. 7, the locking ring 82 is placed about jacket halves 78 and 80, preferably near the front ends 92 and 94 of jacket halves 78 and 80. The top jacket half 78 is rotatable around a first hinge pin 98 while the bottom jacket half 80 is rotatable around a bottom hinge pin 100. In order to open the pressure jacket 72, the locking ring 82 is moved along the length of the top jacket half 78 and bottom jacket half 80 to the injector front face 23, as shown in Fig. 6. This

allows the pressure jacket 72 to be opened by moving the top jacket half 78 about the first hinge pin 98 and moving the bottom jacket half 80 about the second hinge 100. A link (not shown) between the two jacket halves 78 and 80 may be used to regulate the movement of the two halves so they move away and toward each other at the same rate. Alternatively, either the top 5 or bottom jacket halves 78 or 80 may be fixed to the injector front face 23 while the other jacket half is pivotally mounted to the injector front face 23. While in the open position, the syringe 76 may be inserted or removed from the pressure jacket 72. The advantages relating to the first embodiment of the present invention, discussed above, are also realized with this second embodiment.

10 Figs. 8-11 show a third embodiment of the present invention. A fluid injector indicated generally at 110 includes a pressure jacket 112 with a plurality of locking fingers 114 for engaging a syringe 116, shown in an open position in Fig. 10 and a closed position in Fig. 11. Pressure jacket 112 is connected at its rear end 132 to injector head 20 by any suitable means, such as a threaded connection (not shown). Syringe 116 has a cylindrical body 118 having a 15 front end 120 and an open rear end 122. The front end 120 of syringe 116 is tapered and connected to a neck 124. A disk shaped drip flange 126 is formed around the neck 124.

20 The pressure jacket 112 includes a hollow cylinder 128 which is preferably made of clear plastic. A distal end 130 of the cylinder 128 is open to allow loading and removal of the syringe 116. The distal end 130 of pressure jacket 112 has an outside surface 134 which is slightly 25 smaller in diameter than that of cylinder 128. The outside surface 134 of the distal end 130 is threaded (not shown). A plurality of locking fingers 114 (in the illustrative embodiment, six are shown) pivot about respective pivot points 136, as shown in Fig. 10. Each locking finger 114 has a front end 131, preferably beveled, and a rear end 133. Pivot points 136 are located proximate to the rear ends 133 of the locking fingers 114 and are mounted within channels 138 located on the rim of distal end 130. Locking fingers 114 may be kept in position by means of friction and are radially angularly spaced from each other on the rim of distal end 130. It is understood that any number of locking fingers may be used.

30 As shown in Figs. 8, 10 and 11, a locking ring 140, generally cylindrical in shape, is threaded on its interior surface and threaded onto the outside surface 134 of the distal end 130 (threads not shown). The front end 142 of the locking ring 140 is a distal annulus extending radially inwardly to form an open orifice 144 which permits the syringe body 118 to be inserted into pressure jacket 112, but does not permit the drip flange 126 to be inserted into pressure jacket 112. Fig. 10 shows that the front interior surface of the front end 142 is sloped to engage

locking fingers 114 when in a closed position, as shown in Fig. 11 and more fully described below.

Figs. 10 and 11 show that the syringe 116 is inserted into locking ring 140 and cylinder 128 so that drip flange 126 rests on the front end 142. Locking ring 140 is screwed further onto cylinder 128, and thus, moved toward the rear end 132 of cylinder 128, as shown in Fig. 11. Locking fingers 114 are pivoted about their respective pivot points 136 from the open position of Fig. 10 to the closed position of Fig. 11 by the sloped interior surface of the locking ring 142 which engages the distal ends 133 of the locking fingers 114. Front ends 131 of fingers 114 retain syringe 116 in place. When locking ring 140 is unscrewed away from the distal end 130 of the cylinder 128, locking fingers 114 pivot into an open position. A spring member (not shown) may be used to bias the locking fingers 114 into the open position. Syringe 116 may then be removed from or inserted into the pressure jacket 112. The advantages relating to the first embodiment, as discussed above, are also realized by this embodiment.

Figs. 9A and 9B provide details of an alternative configuration of a locking finger. Specifically, the locking finger 314 of Figs. 9A and 9B is an angled locking finger formed by an elongated base member 316 and retaining arm 318, preferably integrally formed therewith. Base member 316 is pivotally mounted to cylinder 128 at pivot point 136. The angle between base member 316 and arm 318 is similar to the angle of the taper of front end 120 of the syringe 116 to permit maximum retention of syringe 116 within pressure jacket 112. As shown in Fig. 9A, syringe 116 may be removed from pressure jacket 112 by moving a screw-threaded locking ring 340 toward pressure jacket rear end 132 on threaded surface 134 of cylinder 128. Alternatively, as shown in Fig. 9B, syringe 116 may be held in place by moving the locking ring 340 away from pressure jacket rear end 132 on threaded surface 134 of cylinder 128. As locking fingers 314 are angled, retaining arms 318 serve as stops to prevent the axially outward motion of syringe 116. Thus, locking ring 340 need not include a sloped inner surface, as described above.

A fourth embodiment of the present invention is shown in Figs. 12 and 13. Fig. 12 shows a fluid injection system indicated generally at 150 having a pressure jacket 152 of a split front plate type, in an open position, while Fig. 13 shows the pressure jacket 152 in a closed position. Similar to the third embodiment of the invention, the pressure jacket 152 includes a cylinder portion 164 which may be mounted at its proximal end 168 to the injector front face 23 by any suitable means, such as screw threads (not shown). A cylindrically-shaped syringe 154 including a neck 156 may be inserted into the distal end 166 of pressure jacket cylinder 164. Syringe 154 further includes an alignment flange 158 comprising two diametrically opposed radially projecting wings 160 and 162 which aid in the alignment of the syringe 154 with respect to pressure jacket

152. In a preferred embodiment, flange 158 is disposed in a plane including the axis of the syringe 154.

Syringe 154 is held in place by means of a combination of first and second front plates 170 and 172. In a preferred embodiment, first and second front plates 170 and 172 are semi-circular in shape, such that each plate 170 and 172 has one straight margin and one arcuate margin. Plates 170 and 172 each contain semi-circular indentations 174 and 176 in their respective straight margins, and these indentations 174 and 176 form a neck access 178 for the neck 156 of the syringe 154. The straight margins of front plates 170 and 172 act as flange slots 180 and 182 which conform to the wings 160 and 162 of syringe 154. First front plate 170 has an end which is connected to a first tie rod 186, which allows the first front plate 170 to be pivoted between an open position of Fig. 12 and a closed position of Fig. 13. Similarly, the second front plate 172 has an end which is attached to a second tie rod 184, which allows the second front plate 172 to be pivoted between the open and closed positions.

Tie rods 184 and 186 have proximal or rear ends which may simply be rotatably mounted to the injector front face 23, or alternatively attached to gears (not shown) located in injector head 20 for automatic opening and closure. The tie rods 184 and 186 are preferably rigidly attached to the front plates 170 and 172.

When the pressure jacket 152 is in an open position as shown in Fig. 12, front plates 170 and 172 are pivoted away from the pressure jacket 152 by rotating the tie rods 184 and 186. For example, sun and planetary gears (not shown) in the head 20 may provide symmetric rotation of the tie rods 184 and 186. The open position allows the insertion or removal of syringe 154. Once the syringe 154 is inserted within the jacket cylinder 164, the front plates 170 and 172 are pivoted into the closed position as shown in Fig. 13. In this closed position front plates 170 and 172 extend across the front end 166 of jacket cylinder 164. When front plates 170 and 172 are pivoted into the closed position, flange slots 180 and 182 act with the syringe flange wings 160 and 162 of the flange 158 to force the syringe 154 into proper angular alignment within pressure jacket 152. In the illustrated embodiment, in proper alignment the syringe flange 158 is parallel to the plane formed by the tie rods 184 and 186. The flange slots 180 and 182 in conjunction with the syringe flange 158 also act to prevent the syringe 154 from rotating during injector head 25 operation.

Fig. 12 also shows that front plates 170 and 172 include latches 192 and 194, respectively, located at respective ends which are remote from or diametrically opposite from front plate pivot points 188 and 190. Latches 192 and 194 clamp onto the distal ends of tie rods 184 and 186 respectively, and are operable to fix the front plates 170 and 172 in the closed

position. Slots 196 and 198 are located near latches 192 and 194, respectively, and are conformable to pivot points 188 and 190, respectively, to permit a snug fit when front plates 170 and 172 are in a closed position. Front plates 170 and 172 may also include conical interior surfaces (not shown) which conform with the front of the syringe 154 when front plates are in a closed position.

5 The advantages of the first embodiment discussed above are realized with this embodiment. Additionally, the use of flange slots 180 and 182 in conjunction with alignment flange 158 allows automatic alignment of the syringe 154 to an asymmetrical injector head drive means, such as a piston (not shown).

10 An alternative to the above embodiment may be realized by making the tie rods 184 and 186 integral to the jacket cylinder 164. A second alternative to the above embodiment may be realized by utilizing a syringe similar to that in Fig. 1 and eliminating the flange slots 180 and 182, particularly if there is no need to automatically angularly align the syringe 154..

15 Figs. 14 and 15 show a fifth embodiment of the present invention. Fig. 14 shows a fluid injector indicated generally at 210 having a pressure jacket 212 of a swing front retainer type in an open position. Fig. 15 shows the pressure jacket 212 in a closed position. Like the other embodiments previously discussed, the pressure jacket 212 is mounted at its rear end 220 on the injector front face 23 by any suitable means. A syringe 214 inserted into the front end 218 of pressure jacket 212, as shown in Fig. 15, includes a neck 226. The syringe 214 is held in place 20 against force exerted by the injector drive means on the syringe plunger (neither shown) by a front retaining plate 222 which has a slot 224 that allows the neck 226 of the syringe 214 to extend from the cylinder 216 through the front retaining plate 222. The slot 224 is significantly smaller in a direction transverse to the longitudinal axis than the diameter of the syringe 214, so that the remainder of the retaining plate may resist forward-directed force placed on it by the 25 syringe 214 during an injection operation. The slot 224 extends from the center of retaining plate 222 in a direction of the pivot of front plate 222 (discussed below) to the margin of plate 222.

30 In a preferred embodiment, the inside surface of slot 224 is contoured to engage the outside surface of syringe neck 226. For example, if neck 226 is cylindrical in shape, the inside surface of slot 224 is cylindrical. If neck 226 is conical in shape, the inside surface of slot 224 is angled.

An adapter 228, which is an annular collar for tie rod connections, is mounted or integrally formed on the injector front face 23 and adjoins the pressure jacket cylinder 216. The collar 228 has a pair of tie rod pins 230 and 232. Bushings 234 and 236 rotate about tie rod pins

230 and 232, forming pivots. Bushings 234 and 236 are connected to and may be integrally formed with to the rear ends of tie rods 238 and 240. The front ends of tie rods 238 and 240 are connected to the front retaining plate 222. It is understood that pins 230 and 232 may be located either on the injector front face 23 or on the exterior of jacket cylinder 216.

5 To open the pressure jacket 212, the tie rods 238 and 240, and front retaining plate 222 are pivoted about the pins 230 and 232 by bushings 234 and 236 which allow the syringe 214 to be inserted into the front end 218 of the jacket cylinder 216. The front plate 222 and the rods 238 and 240 are then pivoted back into place to retain syringe 214. It is understood that an alternative to this embodiment may include a front plate 222 formed by two halves each 10 connected to a rod 238 and 240 such that each halve of the front plate 222 is pivoted into place to retain syringe 214. The advantages relating to the first embodiment, as discussed above, are also realized by this embodiment.

15 Fig. 16 shows a fluid injector indicated generally at 250 having a pressure jacket 252 of a "caulking gun" type. Like the embodiments already described, the pressure jacket 252, when assembled, permits a piston (not shown) housed within an injector head 20 to apply forward force to a plunger (not shown) within a hollow body of a syringe 254, thereby forcing fluid from a front connector end 256 thereof. The pressure jacket 252 has a jacket cylinder 258 which may be made of clear plastic. The jacket cylinder 258 may be rotated about pins 260 and 262 (the last shown in phantom) which are rotatably attached to the front face 264 of the injector head 20. 20 Front face 264 is curved or slanted which allows cylinder 258 to pivot about pins 260 and 262. Cylinder 258 has an open front end 265 by which the syringe 254 may be loaded or removed.

Attached to the injector head 20 is the rear end of an elongated arm 266 which is disposed in parallel to the longitudinal axis of syringe 254 when the latter is loaded into pressure jacket 252 and is ready for an injection operation. A retaining wall 268 is orthogonally attached 25 to the front end of arm 266. The retaining wall 268 has an internal surface 270 which is generally spherical or conical in shape so as to mate with an external spherical or conical surface of a syringe transition region 272 located between a syringe cylindrical body 274 and syringe tip 256. Retaining wall 268 has an upwardly open slot 276 for the insertion of the neck 256 of the syringe 254 when the pressure jacket cylinder 258 is moved to a closed position, as shown in Fig. 17A. 30 The slot 276 is cut in the same direction as the direction of articulation of the pivoting pressure jacket 252.

As shown in Fig. 16, cylinder 258 of pressure jacket 252 is pivoted to an open position to allow the loading or removal of the syringe 254 into the open end 265 of the cylinder 258. The cylinder 258 is then pivoted back to rest against the arm 266 and the syringe neck 256 is lowered

into the slot 276 of the retaining wall 268. The advantages discussed above are also realized by this embodiment.

5 Fig. 17B shows an alternative embodiment to that shown in Fig. 17A. A prong 277 attached to cylinder 258 is provided for engaging slot 276 of retaining wall 268 when the pressure jacket 252 is in the closed position so as to further secure syringe 254 within pressure jacket 252.

10 Figs. 18 and 19 show the final embodiment of the present invention which is a fluid injector 280 having a pressure jacket 282 of a "slideable canopy" type for receiving and retaining a syringe 284. The pressure jacket 282 has a canopy 286 which has an open front end 288 and an open rear end 290. Canopy 286 is slidably mounted on the injector head 20. An opening 292 in the front plate 293 of injector head 20 allows the canopy 286 to be retracted within the injector head 20. Canopy 286 is preferably made of clear plastic. Alternatively, canopy 286 may telescope into or over a fixed tube which extends from injector head 20 (not shown).

15 An arm 294 has a proximal or rear end mounted on the injector head 20. The opposite, distal or front end of the arm 294 is orthogonally attached to a retaining wall 296 which has a slot 298 to allow placement of the neck 302 of the syringe 284. In operation, the syringe 284 is placed on the arm 294 such that the neck 302 of syringe 284 is placed within the slot 298 of the retaining wall 296. The retaining wall 296 has a conical shape to conform to the front of the syringe 284. In order to hold the syringe 284 in place, the canopy 286 is moved along the arm 20 294 as by means of a channel 304, as shown in Fig. 19, formed in the interior surface 306 of the canopy 286. This arrangement allows the canopy 286 to slide on the arm 294 from an open to a closed position or vice versa, allowing the removal or insertion of syringe 284. The advantages discussed above are also realized by this embodiment.

25 The above described embodiments are merely illustrative of the principles of this invention. Other arrangements and advantages may be devised by those skilled in the art without departing from the spirit and scope of the invention. For example, the drip flange and other features described here may be used with other systems as well. Accordingly, the invention should be deemed not to be limited to the above detailed description but only by the spirit and scope of the claims which follow.

## WE CLAIM:

1. Fluid injection apparatus comprising:
  - an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, drive means extendible through said opening and an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and
    - 5 a pressure jacket including first and second jacket halves having interior surfaces conformable to portions of an exterior surface of said syringe, a hinge pin extending from a front face of said injector head, at least one of said first and second jacket halves rotatably mounted on said hinge pin and articulable between an open position allowing insertion and removal of said syringe, and a closed position wherein said jacket substantially surrounds said syringe.
  - 10 2. The fluid injection apparatus of Claim 1 wherein said first and second jacket halves are substantially clear plastic.
  - 15 3. The fluid injection apparatus of Claim 1 wherein said first and second jacket halves have a semi-cylindrical shape.
  - 20 4. The fluid injection apparatus of Claim 1 wherein said pressure jacket, when in said closed position, is disposed around an axis, said hinge pin aligned with said axis.
  - 25 5. Fluid injection apparatus, comprising:
    - an injector head having a housing and a front face, a front opening in said front face for connection to a rear end of a syringe, drive means extendible through said opening and an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and
      - 25 a pressure jacket including first and second jacket halves having interior surfaces conformable to portions of an exterior surface of the syringe, each jacket half having a front end and a rear end, at least one of said first and second jacket halves including a hinge for rotational connection to said front face of said injector housing, and at least one of said first and second jacket halves being articulable between an open position allowing insertion and removal of the syringe, and a closed position wherein said jacket substantially surrounds the syringe.
    - 30 6. The fluid injection apparatus of Claim 5 further comprising means for securing said first and second jacket halves together.

7. The fluid injection apparatus of Claim 6 wherein the securing means includes a locking ring slidably disposed around said first and second jacket halves, said locking ring being placed in a position over said front ends of said first and second jacket halves when said jacket halves are in the closed position, and said ring being placed in a position near said rear ends of said first and second jacket halves when said jacket halves are in the open position.

8. The fluid injection apparatus of Claim 5 wherein said top and bottom jacket halves are substantially clear plastic.

10

9. The fluid injection apparatus of Claim 5 wherein said first jacket half is disposed above said second jacket half.

10. The fluid injection apparatus of Claim 5 further comprising a link coupling said first jacket half and said second jacket half, said link regulating the movement of said first and second jacket halves such that said halves will move away from each other and move toward each other at approximately the same rate.

11. Fluid injection apparatus, comprising:  
an injector head having a housing and a front face, a front opening in said front face for connection to a rear end of a syringe, drive means extendible through said opening and an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe;

25 a first jacket portion affixed to said front face of said housing and extending distally therefrom, an interior surface of said first jacket portion conformable to a like portion of an exterior surface of the syringe;

30 a second jacket portion connected to said first jacket portion by a moveable mechanism, an interior surface of said second jacket portion conformable to another portion of said exterior surface of said syringe, said second jacket portion articulable with respect to said first jacket portion between an open position permitting the insertion and removal of said syringe, and a closed position in which said first and second jacket portions coact to substantially surround said syringe; and

a closure affixed to a selected one of said first and second jacket portions for securing said selected one of said jacket portions to the other of said jacket portions when said second jacket portion is in the closed position.

12. The fluid injection apparatus of Claim 11 wherein said pressure jacket is disposed around an axis in said closed position and a hinge is located between said first and second jacket portions disposed in parallel to said axis.

5

13. The fluid injection apparatus of Claim 11 wherein said first jacket portion is disposed below said second jacket portion when said second jacket portion is in said closed position.

10

14. The fluid injection apparatus of Claim 11 wherein said first and second jacket portions constitute halves.

15. The fluid injection apparatus of Claim 11 wherein said closure is a latch affixed to said first jacket portion.

15

16. Fluid injection apparatus comprising:

an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, drive means extendible through said opening and an opening in the rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and

20

a pressure jacket for holding the syringe to the injector head, the pressure jacket comprising:

a hollow cylinder portion of said pressure jacket having an open front end and a rear end coupled to the injector head; and

25

at least one locking finger having a front end, a rear end, and a pivot axis disposed near said rear end thereof, said pivot axis hingedly connected to said open front end of said cylinder portion, said locking finger pivotable to a closed position such that said front end of said locking finger acts to hold the syringe within said cylinder portion, said locking finger further pivotable to an open position to allow the insertion and removal of the syringe.

30

17. The fluid injector apparatus of Claim 16 wherein said cylinder jacket is substantially clear plastic.

18. The fluid injector apparatus of claim 16 further comprising:

5 at least a second locking finger having a rear end, a front end, and a second pivot axis disposed near said rear end of said second locking finger, said second locking finger radially angularly spaced from said first locking finger around the circumference of said open front end of said cylinder portion, said second pivot axis hingedly connected to said open front end of said cylinder portion, said second locking finger pivotal to a closed position such that said front end of said second locking finger acts to hold the syringe within said cylinder jacket, said second locking finger pivotal to an open position to allow the insertion and removal of the syringe.

10 19. The fluid injection apparatus of Claim 16 further comprising a locking ring with at least one sidewall adaptable to be slidably fitted over said open distal end of said cylinder portion and said at least one locking finger, a distal annulus of said locking ring extending radially inwardly, an interior surface of said distal annulus adaptable to engage said front end of said locking finger when said locking ring is moved in a rear direction, said front annulus causing said locking finger to be pivoted around its respective pivot axis such that said front end of said locking finger is forced radially inwardly.

15 20. The fluid injection apparatus of Claim 19 wherein said front end of said at least one locking finger is substantially beveled.

20 21. The fluid injection apparatus of Claim 19 further comprising at least a second locking finger radially angularly spaced from said at least one locking finger and pivotally affixed to said open front end of said cylinder portion.

25 22. The fluid injection apparatus of Claim 19, wherein said inner surface of said front annulus is sloped.

23. The fluid injection apparatus of Claim 19 wherein said rear end of said locking finger is part of a base member of said locking finger, an arm member of said locking finger having said front end attached to said base member at an angle.

30

24. Fluid injection apparatus, comprising:  
an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, drive means extendible through said opening and an opening in said rear end of said syringe for imparting motive force to a plunger disposed therein; and

a pressure jacket for holding the syringe to the injector head, the pressure jacket comprising:

5 a jacket cylinder having an open front end and a rear end coupled to the injector head;

5 a first tie rod having a rear end attached to the injector head and a front end; and  
a first front plate attached to said front end of said first tie rod, said first front plate pivotable between a closed position for holding the syringe within said jacket cylinder and an open position for allowing the insertion and removal of the syringe.

10 25. The fluid injection apparatus of Claim 24 further comprising:

a second tie rod having a rear end attached to the injector head and having a front end; and

15 a second front plate attached to said front end of said second tie rod and pivotable between a closed position for holding the syringe within said jacket cylinder and an open position for allowing the insertion or removal of the syringe.

26. The apparatus of Claim 25 further comprising:

a first latch attached to said first front plate operable to fix said first front plate in said closed position; and

20 a second latch attached to said second front plate operable to fix said second front plate in said closed position.

25 27. The apparatus of Claim 26 wherein said front plates each have a first end joined to a respective tie rod and a second end remote from said first end, each latch affixed to said second end of a respective front plate.

28. The apparatus of Claim 25 wherein said first plate is pivotably connected to said first tie rod and wherein said second plate is pivotably connected to said second tie rod.

30 29. The apparatus of Claim 25 wherein the jacket cylinder is substantially clear plastic.

30 30. The apparatus of Claim 25 wherein the syringe further comprises a radially extending flange and said first and second plates each include a slot for receiving the flange.

31. The apparatus of Claim 30 wherein said slots are substantially normal to a plane formed by said first and second tie rods when said first and second plates are in said closed position.

5

32. Fluid injection apparatus comprising:

an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, drive means extendible through said opening and through an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and

10 a pressure jacket for holding the syringe to the injector head, the pressure jacket including:

a pressure jacket for holding the syringe to the injector head, the pressure jacket including:

a jacket cylinder having an open front end and a rear end coupled to the injector head;

15

a first tie rod having a rear end pivotally attached to said injector head and a front end;

a second tie rod having a rear end pivotally attached to said injector head and a front end;

20

a front retaining plate joined to said front ends of said first and second tie rods, said retaining plate and said tie rods pivotable between a closed position for holding the syringe within said jacket cylinder and an open position to allow the insertion and removal of the syringe from said jacket cylinder.

25

33. The fluid injection apparatus of Claim 32 wherein the front retaining plate is formed of two halves, each half connected to its respective tie rod for pivoting between the closed and open positions.

34. The apparatus of Claim 32 wherein the cylinder jacket is substantially clear plastic.

30

35. The injection apparatus of Claim 32 wherein said jacket cylinder is formed around a longitudinal axis, said front retainer plate having an opening formed therein to permit a syringe neck of reduced diameter to protrude therethrough when said plate and said tie rods are in said closed position, said front retainer plate opening being smaller in a direction transverse to said axis than a diameter of a body portion of the syringe.

36. The injection apparatus of Claim 34 wherein said opening of said front retainer plate is a slot formed from a lateral margin of said plate through a center thereof, said slot formed in the direction of pivot of said retainer plate and tie rods.

5

37. The injection apparatus of Claim 32 wherein said rear ends of said tie rods are pivotally affixed to an upstanding annular collar of said injector head.

10

38. A fluid injection apparatus comprising:

an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, drive means extensible through said opening and an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and

a pressure jacket for holding the syringe to the injector head, the pressure jacket including:

15

a jacket cylinder formed around a longitudinal axis and having an open front end and a rear end transversely pivotally joined to said front face of said housing to allow said jacket cylinder to be pivoted between a closed position and an open position, an arm having a rear end and a front end, said rear end of said arm affixed to said injector head, a retaining member attached to said front end of said arm, said retaining member retaining the syringe in said jacket cylinder when said jacket cylinder is in said closed position, said jacket permitting the insertion and removal of the syringe when said jacket cylinder is in said open position.

20

39. The fluid injection apparatus of Claim 38 wherein said jacket cylinder is substantially clear plastic.

40. The apparatus of Claim 38 wherein said front face of said injector head is shaped to permit said jacket cylinder to pivot to said open position.

25

41. The apparatus of Claim 38 wherein said arm is aligned with said axis and has a length substantially the same as said jacket cylinder, said open end of said jacket cylinder disposed adjacent said retaining member when said jacket cylinder is in said closed position.

42. The apparatus of Claim 38 wherein said jacket cylinder is supported by said arm when said jacket cylinder is in said closed position.

43. The apparatus of Claim 38 wherein said retaining member is a plate having a slot formed from a lateral margin of said plate through a center thereof.

5 44. The apparatus of Claim 43 wherein said jacket cylinder has a prong extending longitudinally from said front open end, said prong being mateable with said slot of said retaining member.

10 45. Fluid injection apparatus comprising:  
an injector head having a housing and a front opening in said housing for connection to a rear end of syringe, drive means extendible through said opening and an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and  
a pressure jacket including:  
an arm having a rear end coupled to the injector head and a front end;  
15 a retaining member attached to said front end of said arm for retaining the syringe; and  
a retractable jacket canopy slideably affixed to the arm and having an open front end and an open rear end, said canopy being movable to an open position within said injector head such that said open end is placed near said injector head, said canopy movable to extend over the syringe to assume a closed position.

20 46. The fluid injection apparatus of Claim 45 wherein said canopy is substantially clear plastic.

25 47. The apparatus of Claim 45 wherein said arm is aligned with said axis and has a length substantially the same as said canopy, said open end of said canopy disposed adjacent said retaining member when said canopy is in said closed position.

30 48. The apparatus of Claim 45 wherein said canopy further comprises a channel located on the interior of said canopy, said channel being conformable to said arm such that said canopy is supported by said arm when said canopy is in said closed position.

49. Fluid injection apparatus, comprising:  
an injector head having a front opening for connection to a rear end of a syringe;

a first jacket portion affixed to said injector head and extending distally therefrom, an interior surface of said first jacket portion conformable to a like portion of an exterior surface of the syringe;

5 a second jacket portion connected to at least one of said first jacket portion and said injector head, an interior surface of said second jacket portion conformable to another portion of said exterior surface of said syringe, said second jacket portion articulable with respect to at least one of said first jacket portion and said injector head between an open position permitting the insertion and removal of said syringe, and a closed position in which said first and second jacket portions coact to contain said syringe; and

10 a closure affixed to a selected one of said first and second jacket portions for securing said selected one of said jacket portions to the other of said jacket portions when said first and second jacket portions are in said closed position.

50. Fluid injection apparatus comprising:

15 an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, a drive means extendible through said opening and an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and

a pressure jacket having

20 at least first and second jacket segments surrounding at least a portion of an exterior surface of the syringe,

interior surfaces conformable to at least a portion of the exterior surface of the syringe,

25 a mechanism for allowing movement of the first jacket segment in relation to the second jacket segment to enable insertion and removal of the syringe from the pressure jacket, and

means for securing the pressure jacket segments in a fixed relationship upon insertion of the syringe.

51. Fluid injection apparatus comprising:

30 an injector head having a housing and a front opening in said housing for connection to a rear end of a syringe, drive means extendible through said opening and through an opening in said rear end of the syringe for imparting motive force to a plunger disposed in the syringe; and a pressure jacket for holding the syringe to the injector head, the pressure jacket including:

a jacket cylinder having an open front end for receiving the syringe and a rear end coupled to the injector head by a first coupling attachment;

at least one arm member having a front end and a rear end coupled to the injector head by a second coupling attachment; and

5 a front retaining plate attached to the front end of the arm member;

wherein at least one of the first coupling attachment and the second coupling attachment is a pivot means for permitting relative angular movement between the jacket cylinder and the arm member.

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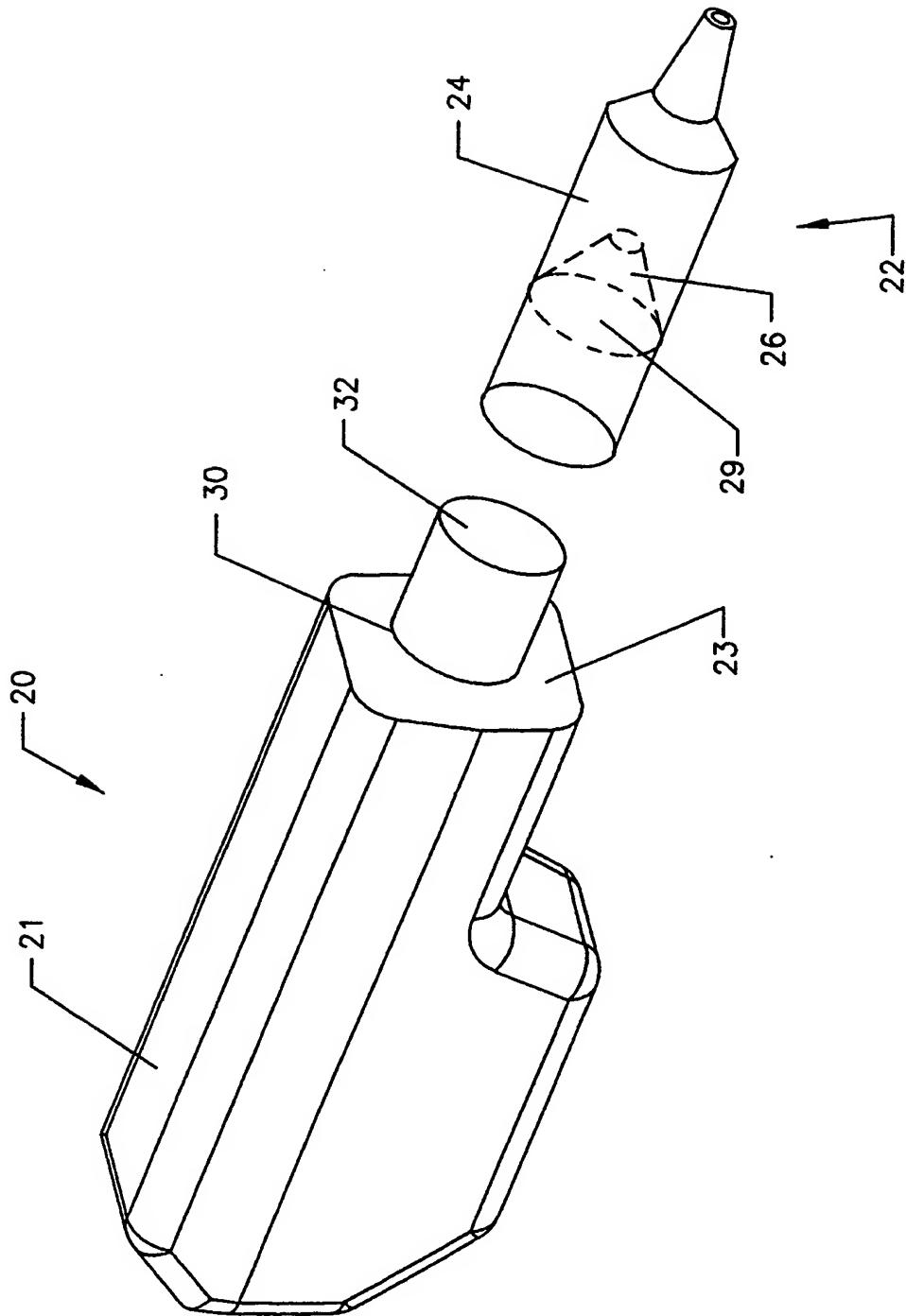


FIG. 1

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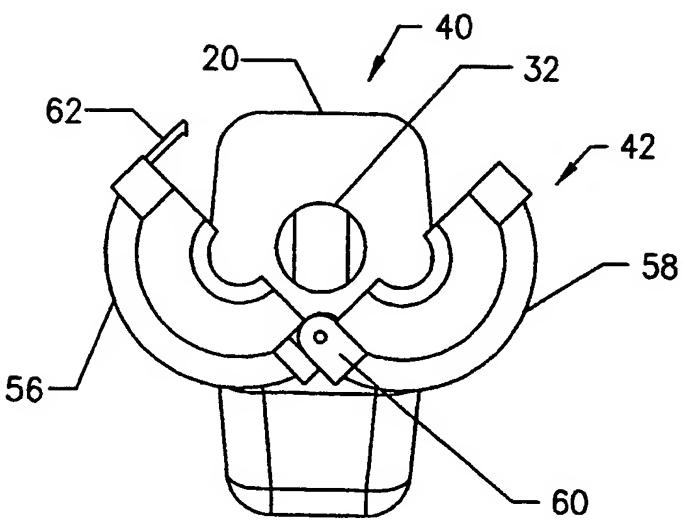


FIG. 3

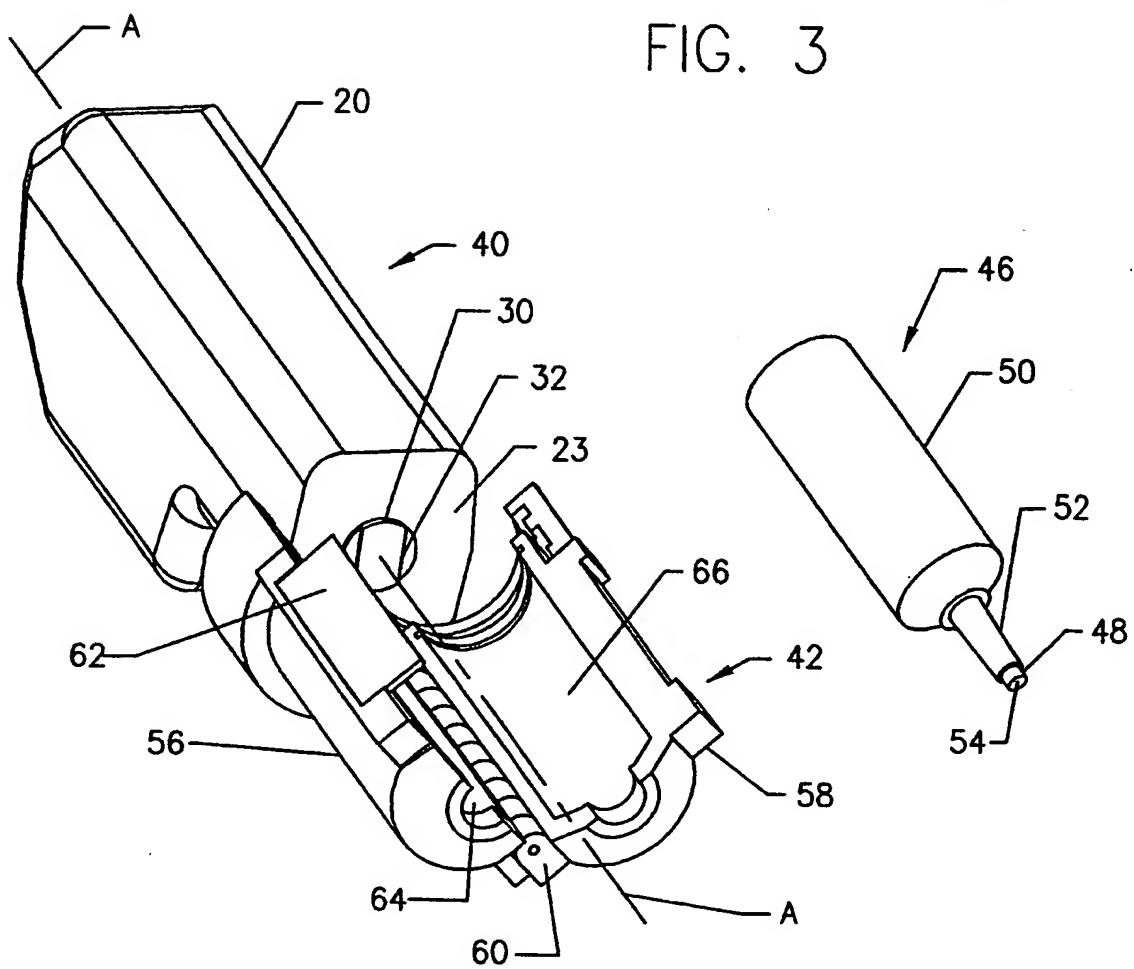


FIG. 2

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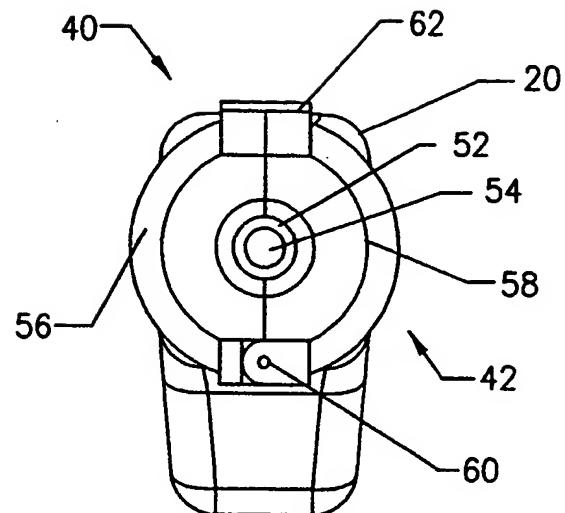


FIG. 5

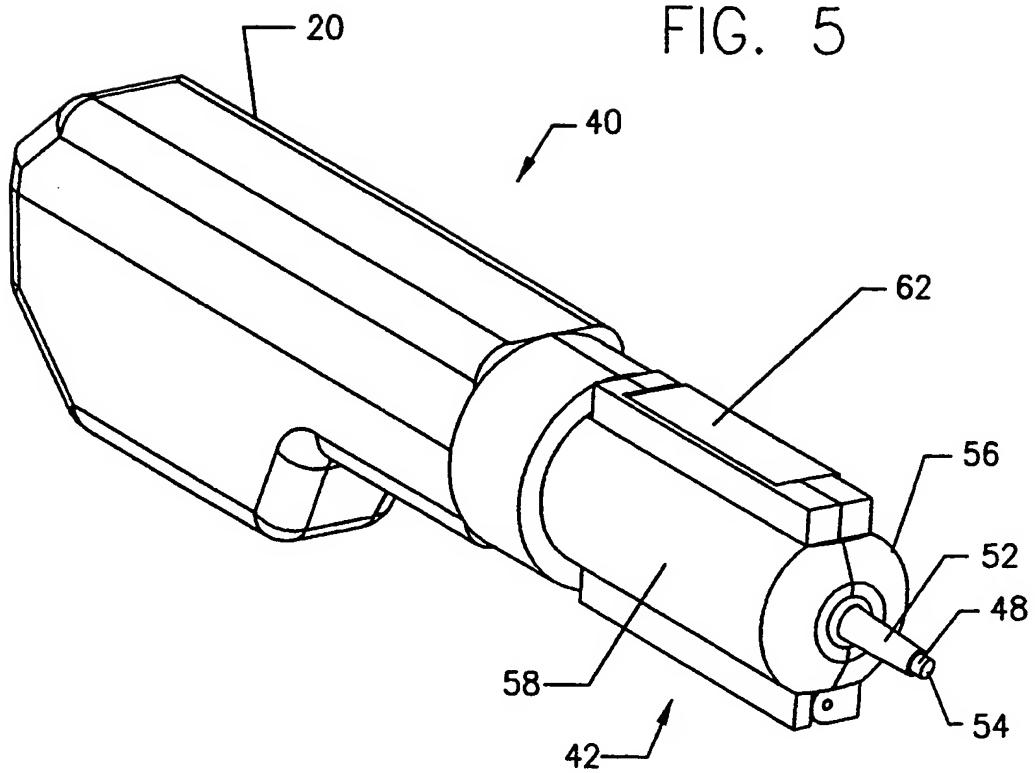


FIG. 4

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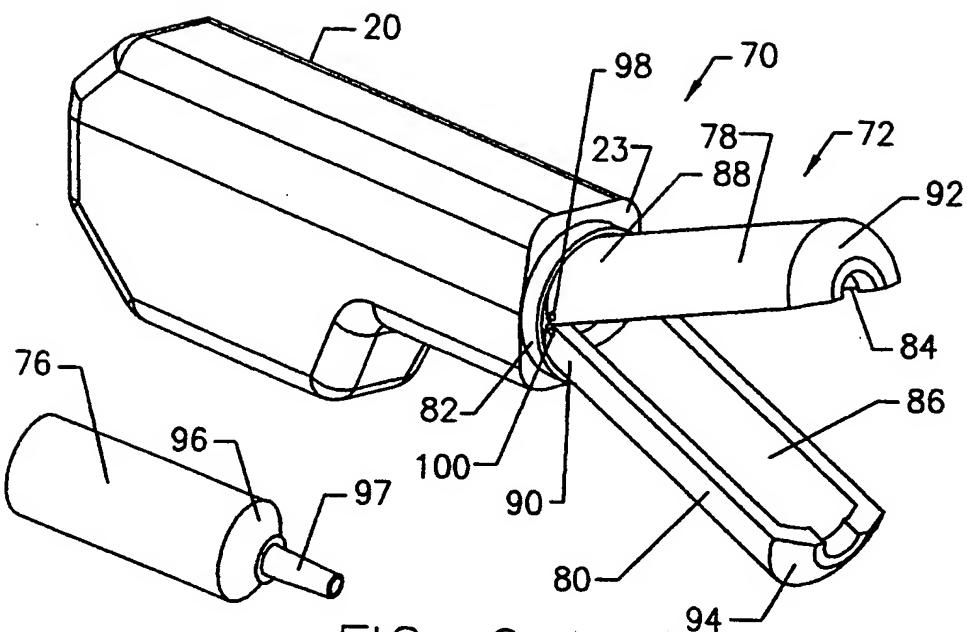


FIG. 6

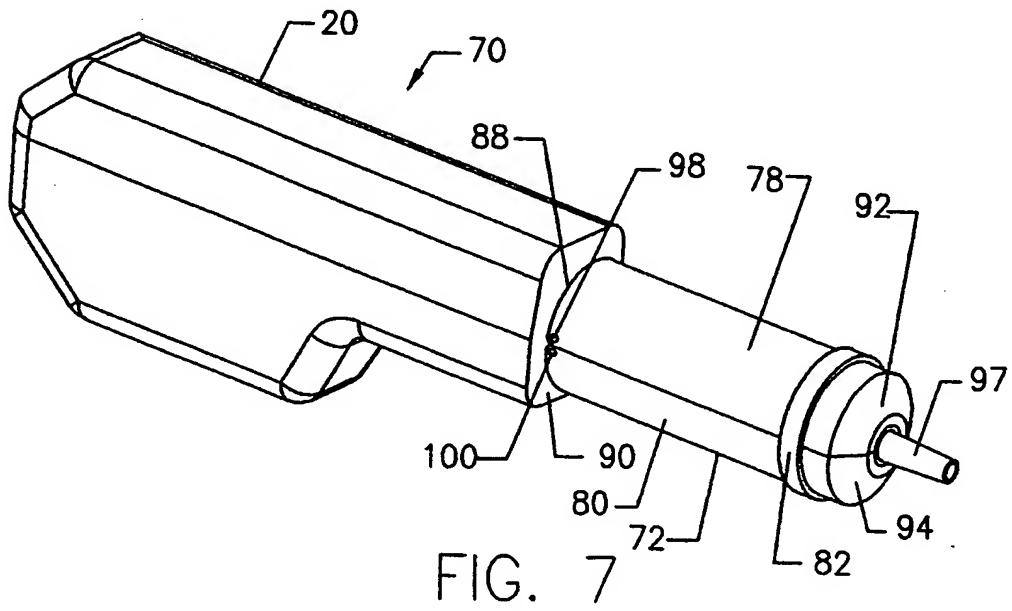


FIG. 7

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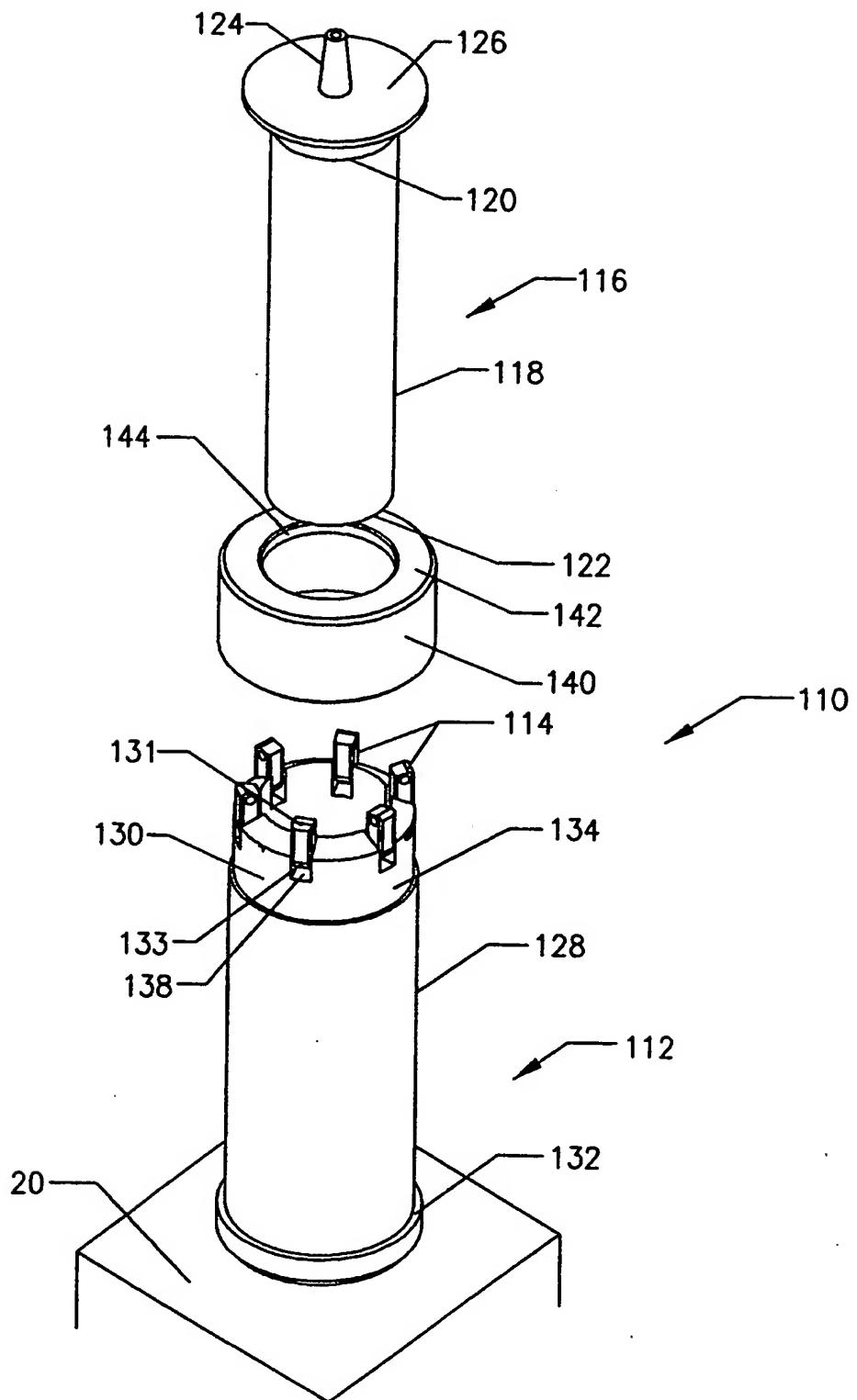


FIG. 8  
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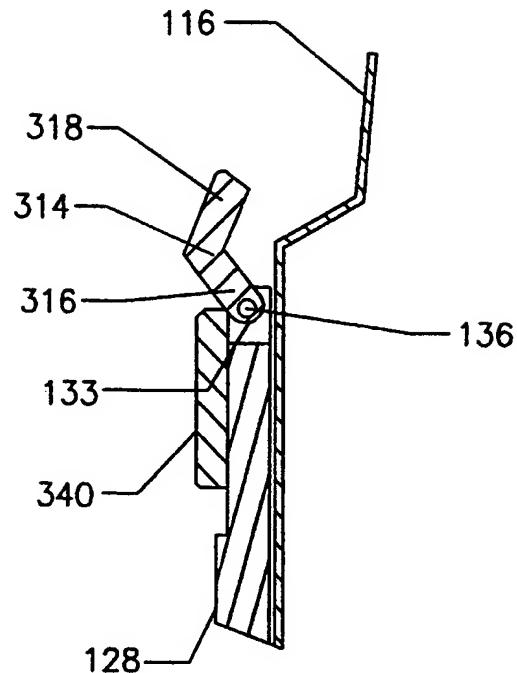


FIG. 9A

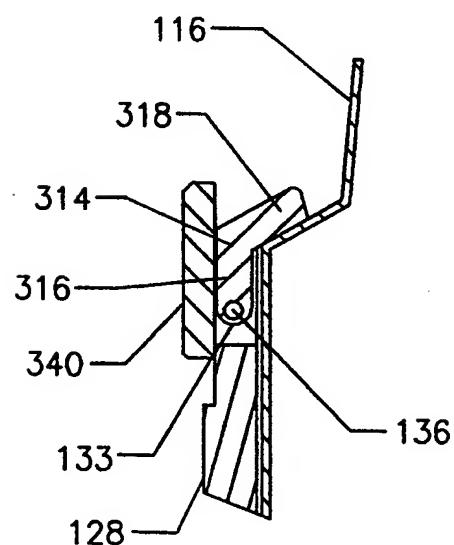


FIG. 9B

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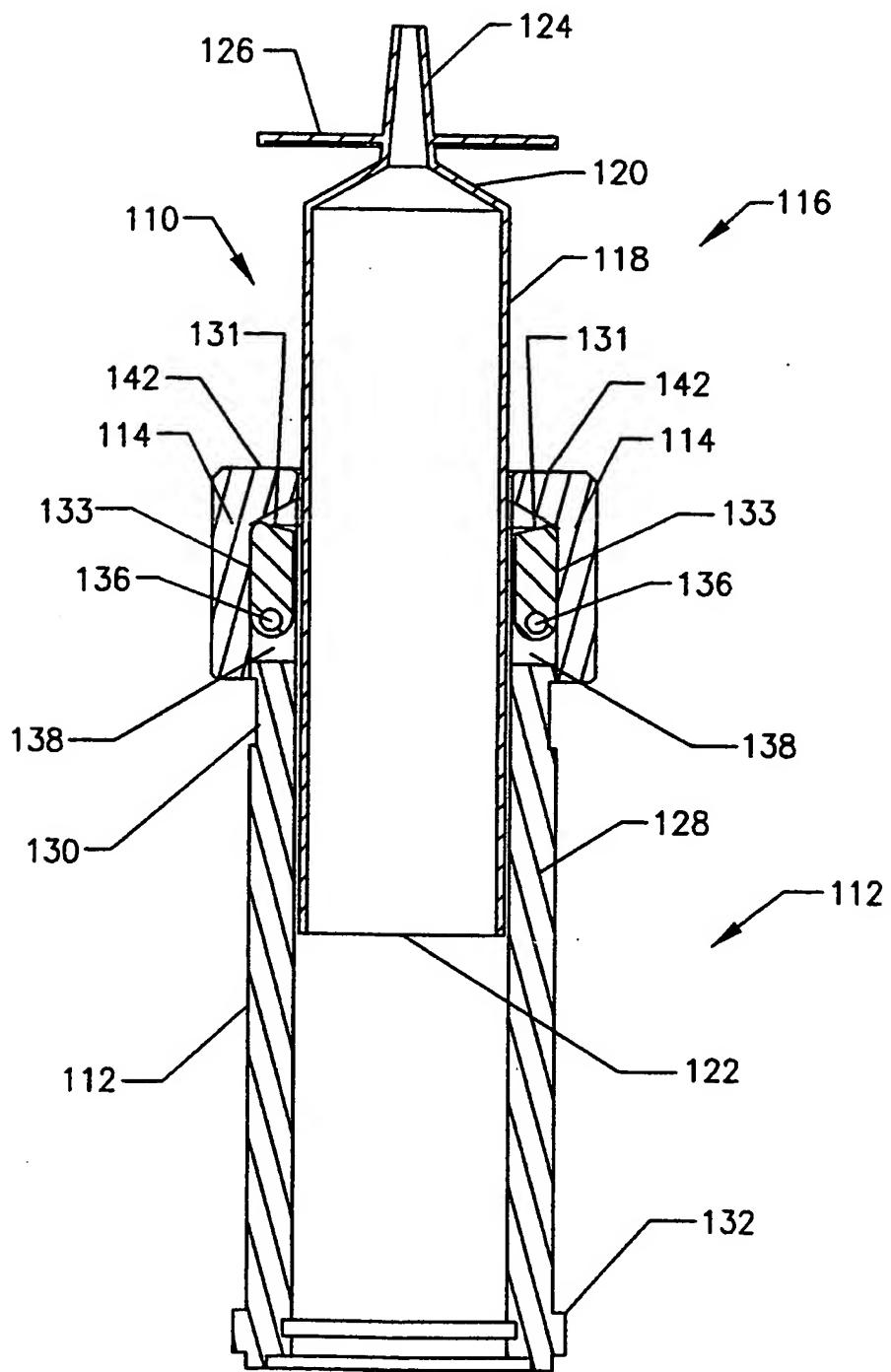


FIG. 10

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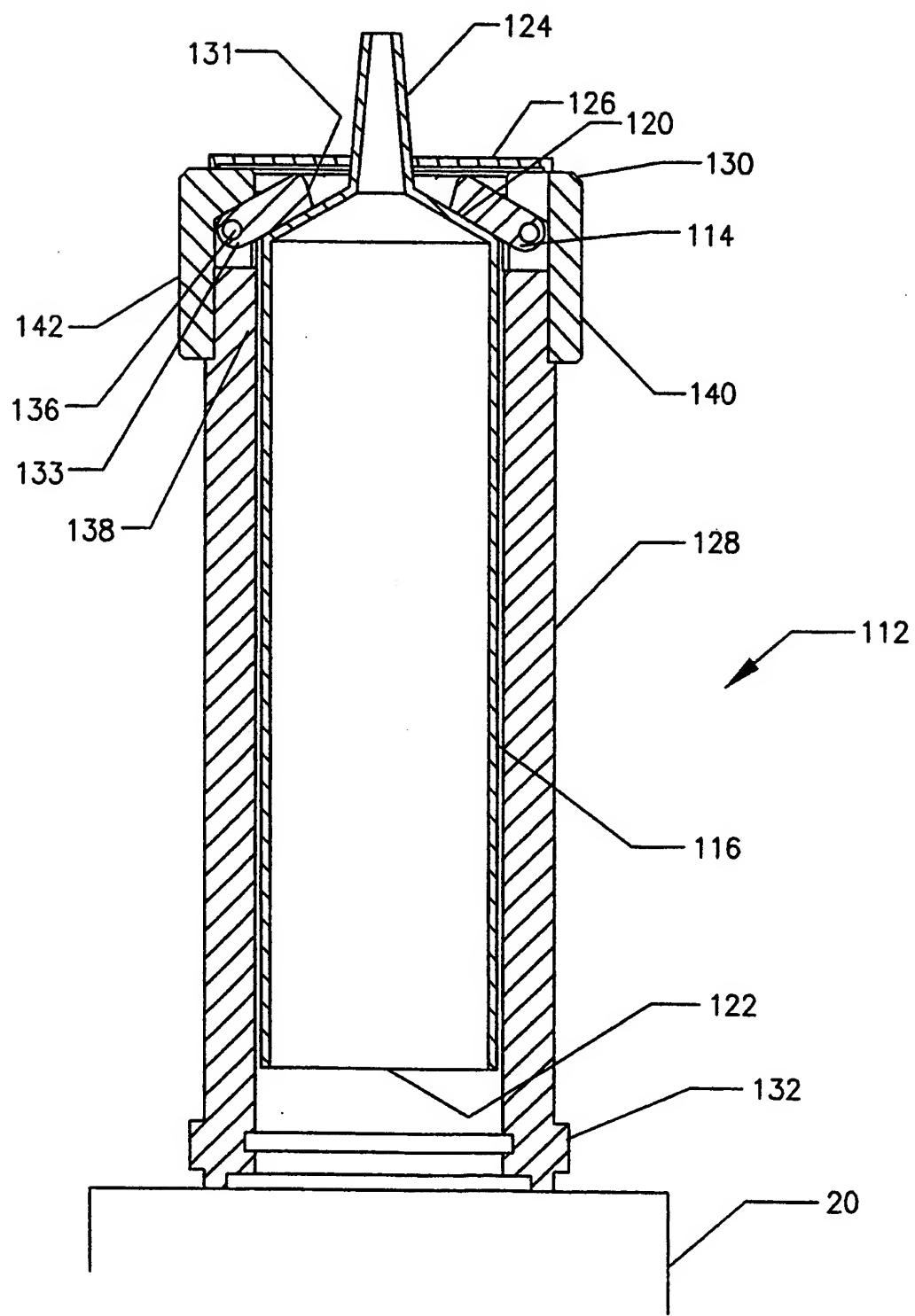
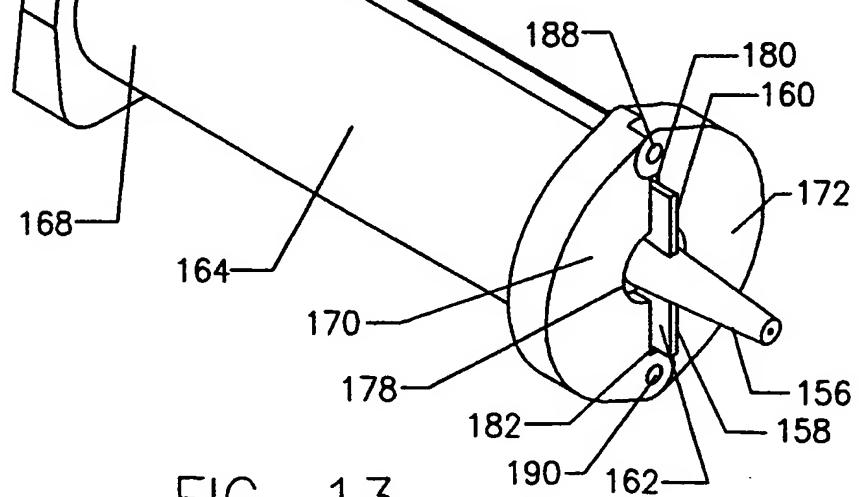
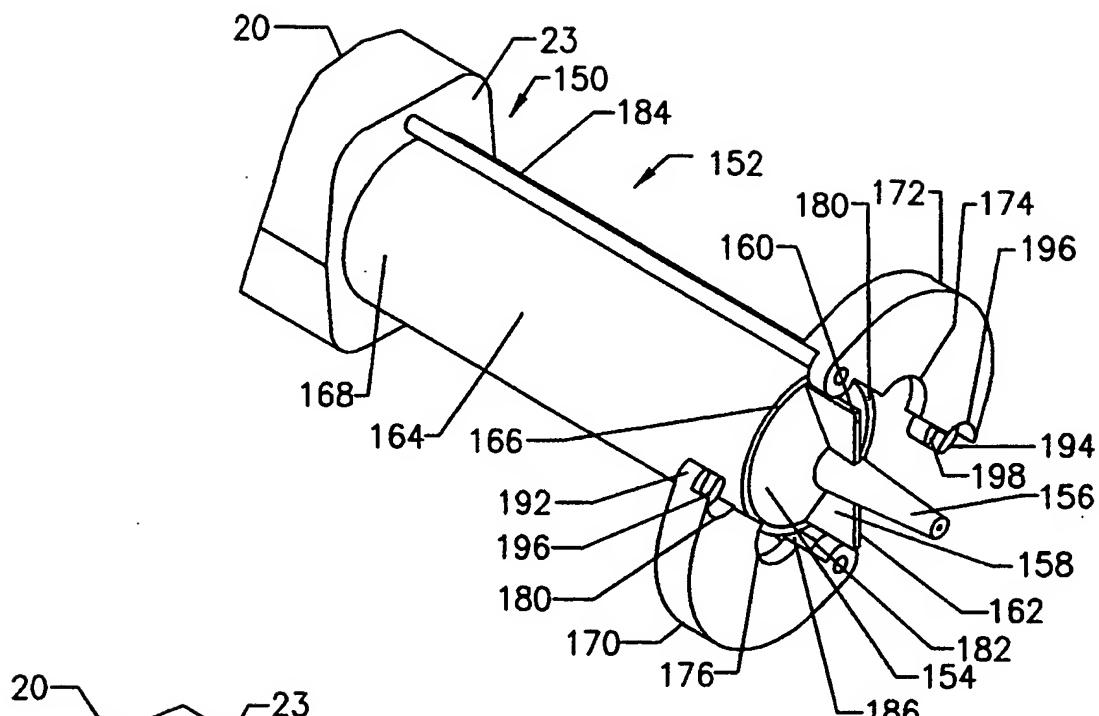


FIG. 11  
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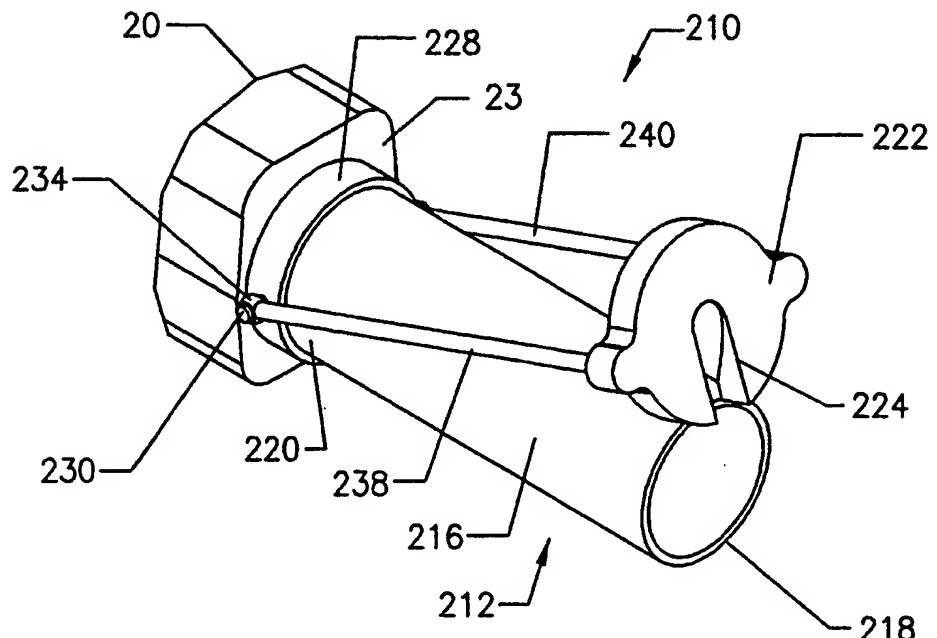


FIG. 14

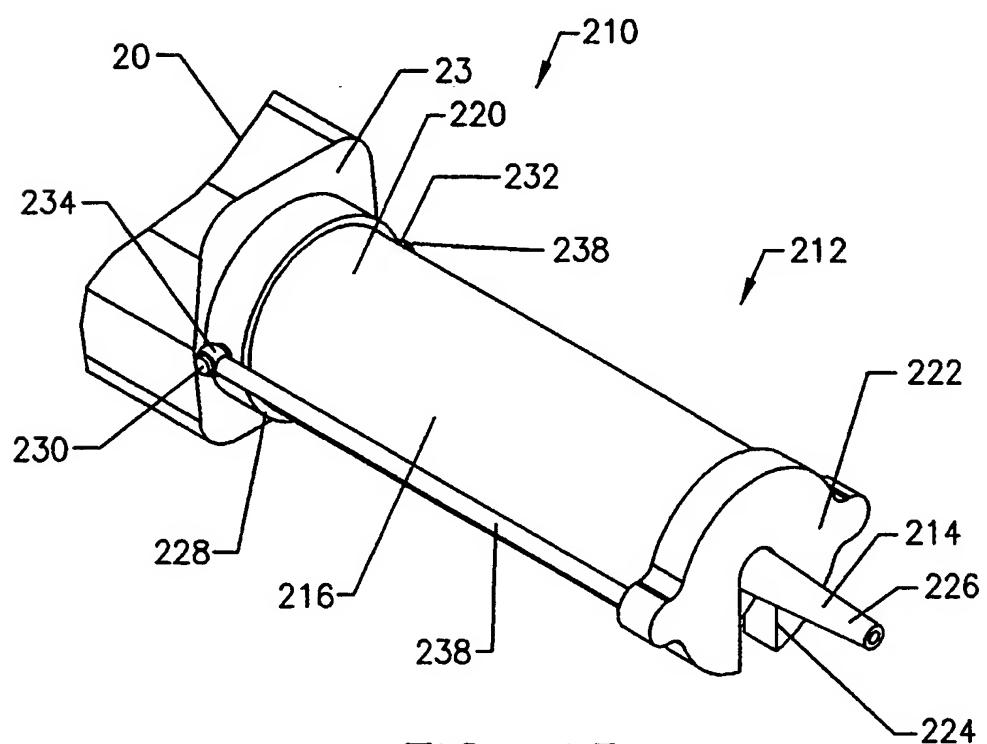


FIG. 15

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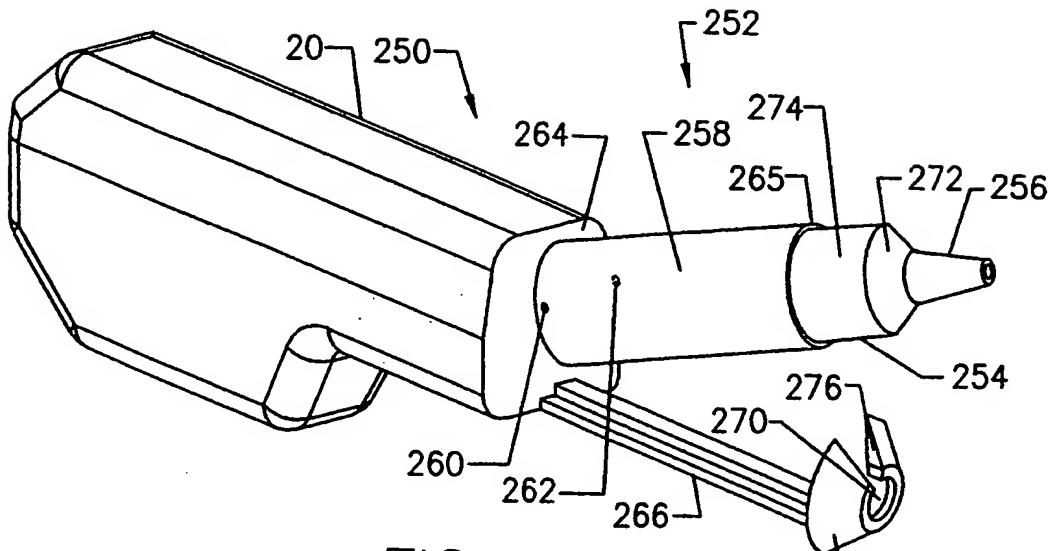


FIG. 16

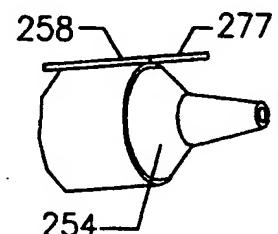


FIG. 17B

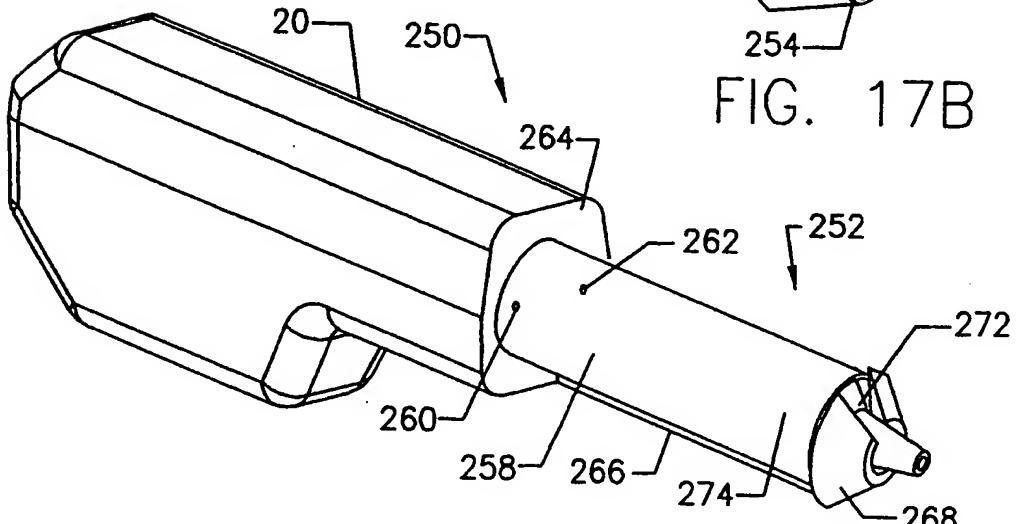


FIG. 17A

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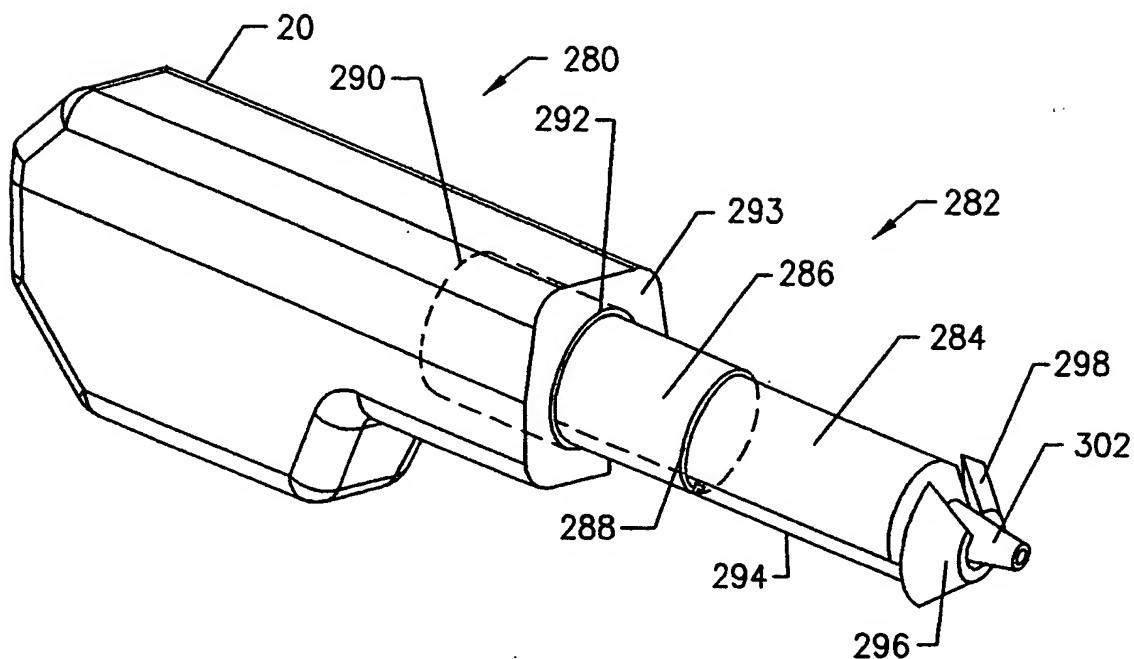


FIG. 18

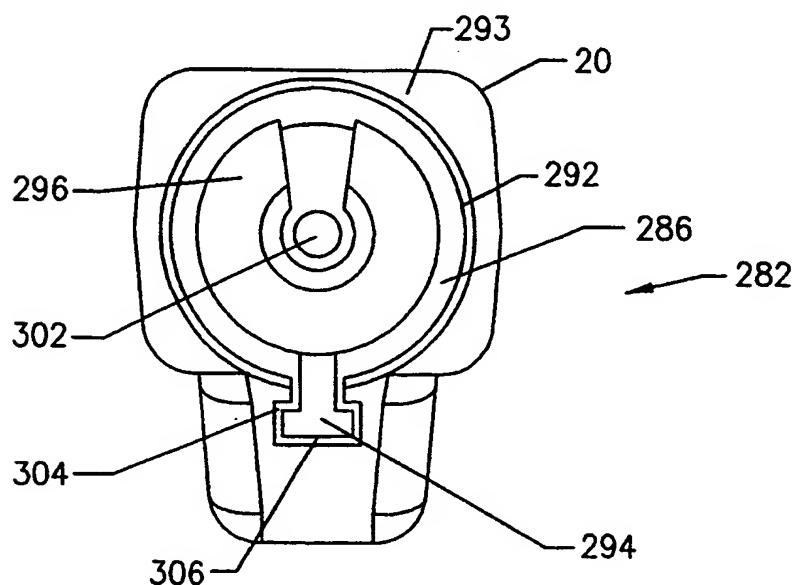


FIG. 19